

A Comparison Between Patients Treated at a Combat Support Hospital in Iraq and a Level I Trauma Center in the United States

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Background: Combat support hospitals (CSHs) function under adverse operational conditions, delivering care to diverse patients. Appropriate allocation of resources and training are dependent on accurate assessments of the populations' needs. This study compared two patient populations treated between December 2004 and November 2005, one from a CSH in Iraq, the other at a civilian Level I trauma center.

Methods: The trauma registry at Oregon Health & Science University was queried to evaluate all trauma patients admitted during the study period. The medical databases of the CSH were retrospectively reviewed. Coalition (Co) patients were US soldiers, their allies, and support staff. Non-coalition (Non-Co) patients were Iraqi Army, Iraqi National Guard, enemy forces, and Iraqi civilians.

Results: One thousand fifty-four patients were admitted to the CSH. Four hundred sixty-five of 696 (67%) Co patients versus 143 of 358 (40%) Non-Co patients had disease-related diagnoses ($p < 0.01$). The remaining 446 patients had traumatic diagnoses; 231 (52%) of these were Co patients. The incidence of battle injury was 59% in Co patients versus 90% in Non-Co patients ($p < 0.01$). One thousand three hundred thirty-nine trauma patients were admitted to Oregon Health & Science University. Civilian patients were older, less likely to be men, and had higher Injury Severity Scale scores than Co and Non-Co patients. Non-Co patients had higher Injury Severity Scale score, longer lengths of stay, and underwent 2.5 times as many operations as Co patients. Of the

civilian patients, 93% were injured by blunt mechanisms compared with 20% of combat victims ($p < 0.01$). Percentages of abdominal, thoracic, and vascular procedures were similar between the three groups, but combat victims had more soft tissue procedures and dressing changes. There were no differences in mortality.

Conclusions: Although CSHs and civilian trauma centers treat significantly different patient populations, the operations performed and outcomes are similar. Non-Co patients consumed 2.5 times more operative resources than did Co patients at the CSH.

Key Words: Combat support hospital, Mortality, Operations, Injury Severity Score, Coalition.

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The delivery of medicine during war time presents numerous complex challenges that differ significantly from civilian practice. Medical care in the Global War on Terrorism is delivered 12,000 miles from home. Conditions are austere and resources are limited forcing caregivers to draw on all of their medical expertise. The safety of personnel cannot be guaranteed as American hospitals represent strategic targets for terrorists. Care is delivered both to American soldiers, coalition forces, and noncoalition forces spanning incredibly diverse cultural populations. Both routine and unusual medical problems must be treated as well as combat casualties. The operational tempo is

intense as mass casualty incidents are common and US patients are transported from the Mideast to Germany and then to the United States frequently in less than 4 days, receiving operations at each destination.^{1,2}

Modern combat wounding patterns differ dramatically from those seen in civilian practice. High powered explosives like improvised explosive devices, rocket propelled grenades, and rockets or mortars have been reported to produce 55% of the casualties seen.³ High powered automatic rifles are typically used as opposed to handguns in civilian casualties. Despite these facts, overall mortality has been shown to be comparable between a Forward Resuscitative Surgical System functioning in Iraq and a major urban Level I trauma center in the United States.¹ The overall case fatality rate in Iraq is 9.1% which is the lowest in recorded war time history and roughly half of that recorded in World War II and Vietnam.^{3–6}

The potentially preventable death rate has been reported to be 15% and the majority of these deaths are from hemorrhage.³ Better training could play a significant role in improving this statistic. Although civilian institutions have trained military residents for a long time, military trauma training centers were established in 1999 in civilian institutions to provide intensive training for forward military teams that focus on the manage-

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Fig. 1. An example of a combat support hospital in Iraq.

ment of trauma victims.⁷ Before this training, it was estimated that the average Army general surgeon performed 1.3 laparotomies, 0.3 thoracotomies, and 0.3 vascular procedures for trauma per year in noncombat settings.⁸

The purpose of this study was to document the activity of a typical combat support hospital (CSH) in Iraq and to compare the presentation and outcomes of coalition and non-coalition combat victims. This study was also designed to compare the combat surgical experience with the experience obtained in a typical university Level I trauma center to better clarify the comparability of the two settings and the areas in which teams trained in civilian centers would require additional experience.

MATERIALS AND METHODS

The 228th CSH was deployed in Tikrit, Iraq during the 11.5-month period from 28 December 2004 until 17 November 2005. Figure 1 shows a typical CSH in Iraq. Its capacity was 12 intensive care unit beds, 30 ward beds, an emergency department, outpatient clinic, and physical therapy clinic. There were two operating rooms each of which could support two operations simultaneously. The hospital had basic laboratory and X-ray capability but did not have computed tomography so head injury patients were triaged elsewhere. The physician complement consisted of one intensivist who was a cardiologist, two emergency department physicians, two family practice physicians, one trauma surgeon, one orthopedic surgeon, one obstetrician, two anesthesiologists, and two certified nurse anesthetists. Since the only cardiologist in Iraq was located at the 228th CSH, all cardiology patients were referred there.

Oregon Health & Science University (OHSU) is one of two designated Level I trauma centers in the state of Oregon. It serves a population of approximately 2 million people and it is also a quaternary referral center for all of Oregon and southwestern Washington. There are 10 orthopedic surgeons and 11 trauma surgeons in the call pool. The department of surgery graduates 12 surgical residents per year and 2 surgical critical



Fig. 2. Oregon Health & Science University in Portland, OR.

care residents per year (Fig. 2). Major burn patients are triaged to the other Level I trauma center in Portland.

A retrospective review of all patients admitted to the 228th CSH was performed. Databases reviewed included the hospital roll which prospectively lists the patients' age, gender, status as coalition or non-coalition, mechanism of injury, a brief list of diagnoses, whether the diagnosis was battle related or not, dates of admission and discharge, and disposition. The operative records for all patients were reviewed as well as intensive care unit and ward databases. Based on all of the information obtained from these databases, an Injury Severity Scale score (ISS) was calculated. The trauma registry at OHSU was queried for all patients admitted during the same period the 228th CSH was deployed and information was recorded for comparison. AIS 98 was used to calculate ISS in both patient populations. All patients entered into the trauma system by emergency medical services are recorded in the trauma registry at OHSU. Mortality was defined at hospital discharge for all groups and only patients who arrived to the hospital alive were included in the analysis.

Coalition patients (Co) were defined as US soldiers and their allies. Noncoalition patients (Non-Co) were defined as Iraqi Army, Iraqi National Guard, and Iraqi civilians. Battle injury related mechanisms were defined as gunshot wound (GSW), explosions, and burn injuries.

Statistical Analysis

Means were compared using analysis of variance with a post hoc Bonferroni correction to allow for multiple comparisons. Categorical data were compared using χ^2 analysis unless the value in any cell was less than 5, then Fisher's exact test was used. All calculations were performed with SPSS version 15.0 (Chicago, IL).

RESULTS

There were 1,054 patients admitted to the 228th CSH between 28 December 2004 and 17 November 2005. Of these, 608 (58%) were disease-related. Four hundred sixty-five of 696 (67%) of Co patients versus 143 of 358 (40%) of Non-Co patients had disease-related diagnoses ($p < 0.01$).

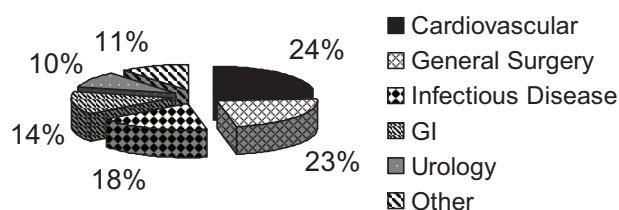


Fig. 3. Medical disease categories of patients admitted to the 228th Combat Support Hospital. GI, Gastroenterology.

The distribution of disease-related illnesses is shown in Figure 3. As the figure reveals, approximately 80% of patients admitted had cardiovascular, general surgery, gastroenterology, or infectious disease diagnoses. Other diagnostic categories not shown in the figure included endocrine, allergy, gynecology, pulmonary, and psychiatry.

The remaining patients (446) were admitted with traumatic diagnoses, 328 (74%) of these were battle related. Of the trauma patients, 52% were Co patients. The incidence of battle injury was 59% in Co patients compared with 90% in Non-Co patients ($p < 0.01$). During the same period, 23,687 patients were admitted to OHSU. One thousand three hundred thirty-nine (5.6%) of these were trauma patients. Patient characteristics, length of stay, mean number of operations,

Table 1 Patient Characteristics, Length of Stay, Number of Operations, and Outcome

	Coalition	Noncoalition	OHSU
Age (yr)	29 ± 10	28 ± 10	39 ± 24*
Male (%)	94	98†	70*
ISS	3 ± 4	7 ± 7†	15 ± 11*
Length of stay	2 ± 2	8 ± 12†	8 ± 10†
No. operations	0.8 ± 1.2	2.1 ± 3.8‡	0.7 ± 1.2
Mortality (%)	6.9	4.5	6.1

Mean values are shown with their standard deviations.

* $p < 0.05$ compared with coalition and noncoalition.

† $p < 0.05$ compared with coalition.

‡ $p < 0.05$ compared with coalition and civilian.

ISS indicates Injury Severity Scale score.

Table 2 Mechanisms of Injury Compared Among the 3 Groups

	Coalition (%)	Noncoalition (%)	OHSU (%)
Gunshot wound	9.5	66.7*	3.7†
Explosion	62.2	20.9*	0.4†
Burn	11.8	9.0	0†
Motor vehicle crash	10.2	3.5*	32.7†
Fall	0.8	0.0	24.3†
Bike or motorcycle crash	0.0	0.0	19.3†
Other	5.5	0.0‡	19.7‡

Other at OHSU includes assaults (9.1%), recreational (4.8%), self-inflicted (3.4%).

* $p < 0.05$ compared with coalition and civilian.

† $p < 0.05$ compared with coalition and noncoalition.

‡ $p < 0.05$ compared with coalition.

Table 3 Percentage of Total Cases Performed in Each of 8 Categories

	Coalition (%) (n = 180 Cases)	Noncoalition (%) (n = 447 Cases)	OHSU (%) (n = 951 Cases)
Soft tissue	39.8	35.9	13.9*
Abdominal	6.6	11.6	10.5
Thoracic	1.1	2.0	3.7
Orthopedic	35.9	24.8†	49.8*
Vascular	1.7	1.6	3.5
Dressing change	5.5	20.3†	0.0*
Head and neck	7.7	2.7‡	10.2
Other	1.7	1.1	8.5

* $p < 0.05$ compared with coalition and noncoalition.

† $p < 0.05$ compared with coalition and civilian.

‡ $p < 0.05$ compared with coalition and civilian.

and outcomes are compared between Co, Non-Co, and OHSU patients (Table 1). Civilian patients were older, less likely to be men and had higher ISS than Co and Non-Co patients. Non-Co patients were more likely to be men, had higher ISS, longer length of stay, and more operations than Co patients did. There was no difference in mortality between the three groups. In severely injured patients, as defined by ISS >25, overall mortality was 20% in Co and Non-Co patients and 21% in OHSU patients ($p > 0.05$).

Mechanisms of injury are compared between the groups in Table 2. Civilian patients were primarily injured by blunt mechanisms (93%) with more than half of the injuries related to motor vehicle crashes and falls. Combat victims were primarily injured by penetrating mechanisms (80%). Co and Non-Co patients had significantly different mechanisms of injury with the majority of Non-Co patients suffering GSWs whereas the majority of Co patients were injured by explosions. There were 951 operative procedures performed on OHSU trauma patients during the study period. There were 447 procedures performed on Non-Co patients and 180 procedures performed on Co patients at the 228th CSH. Table 3 shows the percentage of total procedures performed in each of eight categories among the three groups. Soft tissue debridements and repairs were much more common in Co and Non-Co patients than OHSU patients. Nearly 50% of procedures performed on OHSU patients were orthopedic. There was no difference in the percentage of abdominal, thoracic, or vascular procedures performed on the three groups.

DISCUSSION

The primary finding of this study is that there are both significant differences and similarities between patient characteristics, management, and outcomes at a CSH in Iraq and a Level I trauma center in the United States. Patients injured in Iraq are younger, almost exclusively men and, on average, have a lower ISS. They are primarily injured by high powered penetrating mechanisms as opposed to blunt mechanisms in civilian practice. Soft tissue procedures are much more common in the military setting than the civilian setting.

Alternatively, the majority of hospital admissions in both settings are disease-related and not trauma-related. Orthopedic procedures play a prominent role in both settings. There is no significant difference in the percentage of procedures that general surgeons classically perform to include abdominal, thoracic, and vascular operations suggesting that civilian trauma training and civilian practice provides a significant portion of the background necessary to manage combat casualties. Finally, despite all the differences between the combat setting and the civilian setting, there is no difference in hospital mortality.

There are important differences between Co and Non-Co patients. The primary mechanism of injury for Non-Co patients is GSWs whereas Co patients are typically injured by explosions. Non-Co patients are more significantly injured, have longer length of stay, and receive more operations at the CSH. These differences result from the fact that significantly injured Co patients who cannot return to duty are rapidly evacuated from the CSH to Germany and then to the United States. Non-Co patients stayed at the CSH until they required minimal or no medical care. Non-Co patients represent a significant source of resource utilization and their care must be considered in planning and staffing a CSH. There are no major differences between the types of procedures that are performed on Co and Non-Co patients.

There are several important limitations of this study. ISS calculations of the combat victims were based on a retrospective review of administrative databases that were not designed to collect trauma-related data and it is likely that not all injuries were recorded. OHSU has a mature trauma registry that focuses on prospective data collection. The 228th CSH did not have computed tomography or the ability to perform autopsies. The absence of computed tomography resulted in triage of head injury patients elsewhere changing the patient population. The absence of computed tomography and autopsy capability probably also resulted in some missed injuries, contributing further to lower ISS scores. This study compares patients with primarily penetrating injuries to patients with primarily blunt injuries. The ISS score has been shown to underestimate the severity of injury in penetrating trauma patients.⁹ Finally, by limiting the data collection to data available at the time of discharge, mortality data in all groups are limited. Since severely injured Co patients were transferred out of the CSH relatively early in their course, it is likely that their mortality was underestimated the most. Finally, the results from this single CSH may not be germane to all CSHs in Iraq or Afghanistan.

Schreiber et al. described the establishment of the Joint Trauma Training Center at Ben Taub General Hospital.⁷ The presumption at that time was that trauma training at a busy urban Level I trauma center would at least partially prepare military teams for combat surgical support. Based on the data presented here, with the exception of soft tissue irrigation and debridement, the assumption appears to be valid.

CONCLUSIONS

Although the patient populations treated and the mechanisms of injury sustained are very different between combat and civilian populations, the types of operations performed and outcomes are similar. Non-Co patients consume a large amount of operative and nonoperative resources at the CSH. Trauma training for deployable military surgical teams at Level I trauma centers is justified.

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DISCUSSION

Dr. Lorne H. Blackbourne (Trauma/Critical Care/Burn Service, Brooke Army Medical Center; and US Army Institute of Surgical Research, Fort Sam Houston, TX): As combat surgeons strive to optimize care of combat wounded we have a readily available example of the best trauma care systems in the world, the civilian Level I trauma centers in the United States. This article represents the first attempt to compare side by side the trauma care at a Combat Support Hospital (CSH) and a civilian Level I trauma center in the United States. Although the concept of this article is landmark, the data accrued for comparison and contrasting to the Level I trauma center in Oregon is not.

The CSH in this study is not representative of the capabilities of a CSH from either a practical or US Army doctrinal standpoint. The CSH in this study is an example of the highly flexible approach to the medical needs in a combat zone and this CSH was apparently established as a facility specializing in the care of nonbattle injury. The CSH in this study has no computed tomography (CT), one general surgeon (61J) on staff (less than the 3 surgeons available at a US Army For-

ward Surgical Team—a military level IIb facility), and few surgical subspecialists. The comparison with a Level I civilian trauma program would have been much better served comparing data from a more robust CSH operating in the same area of operations. Because of the short term follow up (2 days for coalition patients), lack of head injuries, and the different determination of the Injury Severity Scores, the mortality at the two separate surgical facilities does not allow for a fair comparison. Because of these discrepancies, statistical analysis of mortality and operative data comparing the CSH in this study and the Level I civilian center is of no practical importance other than the individual data from each facility representing historical data for future studies.

While cognizant of the inherent difficulties in collecting data in a deployed setting, future studies comparing civilian and deployed military facilities should optimally include number of mass casualty situations, injury stratification (down to specific organ injury), specific anatomic injuries performed by deployed general surgeons versus subspecialists in civilian Level I, accurate ISS scoring, logistical requirements (especially blood and blood products), total number of operative procedures, available surgical subspecialists, ICU requirements, and hospital morbidity and mortality (stratified by injury mechanism and anatomic sites) at discharge. Tracking and recording operations performed, morbidity and mortality of coalition patients transferred to several different facilities in the United States is essential in any military trauma care comparisons to civilian centers.

The value of this study is that it represents the beginning of the process of comparing the injury patterns and capabilities of deployed military surgical facilities to civilian Level I trauma centers. Analyzing the areas of potential deficiency and subsequently improving capabilities will allow for the optimal care of combat wounded and optimal training of surgical personnel. This article starts this process.

Dr. Martin A. Schreiber (Department of Surgery, Section of Trauma and Critical Care, Oregon Health & Science University, Portland, OR): I would like to thank Dr. Blackburne for his careful review of this work. He has made several important points.

The 228th CSH represented one of a complete CSH. It was located at a forward operating base that housed a large cohort of fighting troops in a high conflict area. The hospital was robust.

In light of the fact that all of the CSHs in Iraq are very different, one could argue with the validity of using any of them for a comparison with civilian care but this was the one with which I was most familiar.

The issue concerning in-hospital mortality is an important one. However, mortality rates reported in this study are comparable to those reported by Holcomb et al. for the entire conflict.

Like Dr. Blackburne, I look forward to better data collection in the future and I appeal to the organizers of this meeting to create a single IRB process that would permit investigation of combat casualties throughout injury, treatment, recovery, and rehabilitation.